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ABSTRACT

This study investigated the effects of two modes of instruction; the experiencing mathematics instructional method, and the direct instruction expository method, and two levels of mathematics anxiety, high and low, on mathematics achievement. The final sample consisted of 160 students enrolled in a remedial arithmetic course in a four-year college in Puerto Rico. A two-way analysis of covariance with pretest in basic skills in mathematics as covariate was used to test the hypothesis that different instructional interventions reduce mathematics anxiety and increase mathematics achievement. It was concluded that: (1) either of the two instructional interventions can be successfully employed to improve mathematics achievement of remedial college students; and (2) although the difference in adjusted posttest means was not statistically significant, the gains in mathematics achievement of both groups on posttest scores were considerable. (Author)

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THE EFFECTS OF TWO INSTRUCTIONAL INTERVENTIONS IN MATHEMATICS ANXIETY ON ACHIEVEMENT OF REMEDIAL COLLEGE STUDENTS

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Abstract

This study investigated the effects of two modes of instruction --the experiencing mathematics instructional method and the direct instruction expository method-- and two levels of mathematics anxiety--high and low-- on mathematics achievement. The final sample consisted of 160 students enrolled in a remedial arithmetic course in a four year college in Puerto Rico. A two-way analysis of covariance with pretest in basic skills in mathematics as covariate was used to test the hypothesis that different instructional interventions reduce mathematics anxiety and increase mathematics achievement. It was concluded that (1) either of the two instructional interventions can be successfully employed to improve mathematics achievement of remedial college students; and (2) although the difference in adjusted posttest means was not statistically significant, the gains in mathematics achievement of both groups on posttest scores were considerable.

What is Mathematics Anxiety?

Mathematics anxiety has been identified as an important factor in explaining both mathematics avoidance and underachievement. It is an experience of mental disorganization, panic, and fear that prevents a person from learning mathematics (Donady and Auslander, 1980). It is present in daily situations such as in people who cannot balance their checkbooks, who cannot compute their income tax, and who cannot add without using their

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fingers. Mathematics anxiety affects the student in two ways: (1) level of performance on the required task and (2) amount of mathematics taken beyond the required minimum (Smith, 1979). Mathematics anxiety plays an important role in mathematics achievement and mathematics avoidance. Kogelman and Warren (1979) stressed that if there is a key to successful comprehension of mathematics, it is the overcoming of anxiety of the subject, and using the same skills one uses with other subjects and knowledge areas, for mathematics achievement.

Pace (1981) stated that there is no consensus in the definition of mathematics anxiety. It appears that mathematics anxiety means essentially whatever one chooses to believe it means. Each person's subjective view, pro or con, is maintained and held by him as the objective view of what mathematics anxiety treatment involves.

Heller (1982) defined mathematics anxiety as a range of emotional feelings about mathematics that (1) causes its victims to suffer mild to severe physical discomfort; (2) interfere with their ability to concentrate, pay attention, and assimilate mathematical information; and (3) impedes their capacity to deal with mathematical concepts and manipulations in school, in their choice of career and at work, and in everyday situations.

Kogelman and Warren (1979) defined mathematics anxiety as an intense emotional reaction to mathematics based on past experiences. This reaction to mathematics guides and controls the indivual's approach to mathematics to such an extent that doing mathematics becomes extraordinarily difficult, if not impossible. From past experiences most adults have discovered that mathematics is dull, confusing and obscure, difficult and sometimes impossible to understand (Crawford, 1980).

Wright and Miller (1981) established that mathematics anxiety is a

variable that may influence mathematics performance. They concluded that low mathematics achievement may be more the result of the students' attitudes towards mathematics than of general aptitude in this subject area. Alexander and Cobb (1984) concluded that definitions of mathematics anxiety should be modified to include apprehension about taking mathematics tests and about receiving the outcomes of mathematics evaluation. These research studies have consistently identified mathematics test anxiety to be a component of mathematics anxiety.

Stressful situations generally elicit emotional arousal that, depending on the circumstances, may have informative value concerning personal competency. Emotional arousal is another component source of information that can affect perceived self-efficacy in coping with threatening situations. Bandura (1977) concluded that fear reactions generate further fear of impending stressful situations through anticipatory self-arousal. He stated that by conjuring up fear-provoking thoughts about their ineptitude, individuals can arouse themselves to elevated levels of anxiety that far exceed the fear experienced during the actual threatening situation. Bandura (1977) further noted that psychological procedures alter the level and strength of self-efficacy, which plays a central role in the analysis of changes achieved in fearful and avoidance behavior.

Subjects

The final sample for the study consisted of 160 students selected at random from 220 freshman students enrolled in a remedial course of mathematics (Math 105) at a private university in Puerto Rico. The majority of the students in the above university are considered underachievers lacking the basic skills of mathematics and other areas of study. An analysis of the [illegible] Examination Board (CEEB) revealed that for the final sample

(n=160) the mean score in verbal aptitude was approximately 413, in mathematics 422, and in English 391 out of a maximum of 800 points. At least 80% of the freshmen entering the University scored below 599 of the total of 800 points in the CEEB, thus they lacked basic mathematics and literacy skills. Most of them have little experience in problem solving, underdeveloped observational powers, and minimal exeperience inindependent thinking. To overcome their deficiencies and low motivation, many of them required remedial aid and intensive counseling.

From the accessible sample, 80 were identified as high anxious students (HAS) and 80 low anxious students (LAS) in mathematics based on the results on the Mathematics Anxiety Rating Scale (MARS). To be classified as HAS or LAS in mathematics the mean of the MARS scores of the sample under consideration were evaluated as suggested by Suinn (1972) developer of the MARS scale if the student's score was at or above 248, he or she was identified as HAS considering 70% as the cutoff point. If his/her score was below 176 the student was considered as LAS.

The final sample for this study consisted of students with 400 points or less in the CEEB which were clearly identified as remedial students in mathematics according to the requisites of the University's Institute of Science and Technology. Forty students participated in each treatment group in terms of a specific intervention. To decide which students were to be enrolled in the remedial arithmetic course, after considering the CEEB scores, the investigator administered a placement test to the students which determined previous mathematics achievement. This multiple choice test consisted of 36 items. Each item addressed a fundamental skill or concept in the area of arithmetic. If the student obtained a score below 80%, they were enrolled in the arithmetic course.

Materials

The materials used to study the effects of the two instructional methods on mathematics achievement of the subject were: the Mathematics Anxiety Rating Scale (MARS), the Basic Math Skills Test (pretest); and the mathematics mid-term test (posttest).

To determine the levels of mathematics anxiety in the students, the MARS instrument was used. This scale is a 98-item scale composed of brief descriptions of behavioral situations that may arouse different levels of anxiety in the area of mathematics.

The instructional interventions presented the mathematical topics in a direct manner. In treatment 1 the main focus was on mathematics anxiety reduction and the secondary focus was on learning basic skills in mathematics. Treatment 2 focused on learning basic mathematics skills with emphasis on the teacher's role. Mathematics topics were presented by lectures.

Instructional Interventions

Tobias and Weissbrod (1980) asserted that there is no typical technique or intervention to help the student to overcome mathematics anxiety. Some researchers and educators prefer workshops which focus on changing the atmosphere of the classroom from one of tension and competition to one of confidence and trust. Leraning mathematics remains as the ultimate goal of the workshops; learning how to replace debilitating habit with self-instruction and self-encouragement is the immediate goal (Tobias and Weissbrod, 1980). Other authorities identify interventions which provide the learner with a positive mathematics experience, or emphasize self-awareness of how mathematics anxious students impede their own learning. This study dealt with two instructional interventions: the experiencing mathematics approach and the expository instructional method.

The Experiencing Mathematics Materials Approach

Sharing experiences allow students to perceive that others share their

same anxiety. Recognizing this situation is the first step to reduce anxiety (Crwaford, 1980; Kogelman and Warren, 1979). For Piaget (in Joyce and Weil, 1980) the students' role in the learning activity must be active. The instructor's role is to arrange and organize learning experiences providing the students with a setting in which they construct knowledge for themselves through questioning and lectures (developmental model). These investigators combined Piaget's developmental model with Mathison's model (1977). The experiencing mathematics instructional method consisted of three phases: (1) interview and a written record of the student interview, (2) the lecture, and (3) group discussion sessions. Because of the special characteristics of the sample such as low achievers and dependence, class topics were presented through lectures, focusing on the student participation and discovery. The instructional setting for this treatment focused on: (1) discussion of lectures and mathematics anxiety articles; (2) students' active participation; (3) students learning of new concepts through questions and teacher's clarification; and (4) the teacher's active demonstration of their interest in the learning processes of their students. During the interview the instructor collected personal information of the student, grades, results on mathematics tests, and observations about student's reactions toward mathematics. The interview has as ultimate goal to build positive mathematics attitude (Crawford, 1980). The interview was organized in such a way that every student met his/her professor for ten minutes in alternate weeks (three times). The third phase--group discussion session--consisted in the organization of groups of five members each in the classroom. They met during the last 20 minutes of the class, once a week. The instructor had to observe and ascertain that the students did what was expected. The Manual's articles were discussed in the group, and finally each group presented a

concluding sentence. Counselors and other faculty members were invited to present brief conferences on topics such as study habits, motivation, self-concept, myths about mathematics and mathematicians. This time was also devoted to discussion of students' past and present experiences with mathematics.

The Direct Expository Instructional Method

Ausubel (in Joyce and Weil, 1980) proposed a mode of instruction where the teacher is seen as a lecturer. The instructor must present, explain, integrate, and interrelate the material in the learning task with previously learned material. The students should operate on the material as they receive it by relating the new learning material to personal experiences and to their existing cognitive structures, and by taking a critical stance toward knowledge (Joyce and Weil, 1980). In this model the teacher is the person who designs the hierarchy of knowledge in the subject area and also makes decisions about definitions and processes.

Through the direct instructional method the student was provided directly with concepts, principles, and basic skills by the teacher. The role of the teacher is emphasized through this mode of instruction. The teacher pointed out discrepancies, conflicts and similarities between existing knowledge and new knowledge. The teacher translated the new material into a frame of reference that had personal meaning to the student. New ideas were consciously related to previously learned content.

The proposed treatments or instructional interventions in this study presented the mathematical topics in a direct manner. In treatment 1 the main focus was on mathematics anxiety reduction and the secondary focus was on learning basic skills in mathematics. Treatment 2 focused on learning basic mathematics skills with emphasis on the teacher's role. Mathematics topics were presented by lectures. Studies by researchers such as Guthie (1967), Lasher (1981), Mathison (1977), and Woodruff, Shimabukuro and Frey (1965) have suggested that low achievers improve their acquisition of knowledge through traditional methods such as lecturing. The instructors

were advised by the investigator to present at times easy material to the students. The purpose of this action was to reduce students' anxiety and contribute to their success in understanding mathematical concepts.

Findings

The analysis of covariance for the posttest scores was carried out to compare the two treatments and the two anxiety levels. This analysis was utilized to determine whether there was any interaction between the treatment conditions and the anxiety levels. Significance levels were set at .05 for all statistical tests employed.

To determine whether the treatment groups, in terms of mathematics anxiety levels, were statistically different, means, variances, and standard deviations were obtained for each subgroup on the pretest on basic mathematic skills as reported in Table 1.

Table 1

Mean and Standard Deviation for the Scores on the Basic Mathematics Skills Test (pretest on mathematics achievement)

	Treatment Groups								
	1			2			Both treatments		
Anxiety Levels	N	Mean	SD	N	Mean	SD	N	Mean	SD
High	40	30.62	8.90	40	35.83	11.69	80	33.23	10.71
Low	40	36.27	12.71	40	39.65	12.22	80	37.96	12.58
Both	80	33.45	10.17	80	37.74	12.11	160	35.59	11.92

Considering the means on the Basic Mathematics Skills Test (pretest) it is clear that the mean for the direct instructional method (34.34), SD = 12.11, was higher than the mean for the experiencing mathematics method (33.45), SD = 10.17. A difference of 4.29 can be noticed, so it could be expected that the two groups were different. Once these measures were obtained, the F-max test indicated that there were no significant differences. Thus homogeneity of variance was determined for all groups on the pretest scores.

In determining whether the mean difference between the groups was significant, a two-way analysis of variance was used to analyze the pretest scores on the Basic Mathematics Skills Test on achievement in mathematics. A significant difference between treatment group with an obtained F ratio of 5.30 at the .05 level of significance was found. A significant difference between the anxiety levels with an obtained F ratio of 6.71 significant at the .05 level of significance was also determined. The F ratio obtained emphasizes differences between the two anxiety levels to which subjects had been assigned. Pretest scores on achievement were subsequently used as a covariate with post-test scores in the analysis of covariance.

Tests on the assumptions of homogeneity of variance were made. Since there was a significant difference between pretest scores of the group, ANOCOVA was an appropriate method to be used to adjust posttest means for initial difference on pretest and also to reduce error variances. The analyses utilized the posttest scores (mid-term test), as the dependent variable.

Means, variances, and standard deviations were obtained for each sub-group on the posttest (mid-term test) in basic mathematics skills to calculate if their achievement was statistically different. Obtained results are reported in Table 2.

Table 2

Means and Standard Deviations for Posttest Scores on the Posttest in Basic Mathematics Skills

	Treatment Groups								
	1			2			Both Treatments		
Anxiety Levels	N	Mean	SD	N	Mean	SD	N	Mean	SD
High	40	59.53	16.16	40	64.03	16.41	80	61.77	27.75
Low	40	65.88	16.77	40	65.88	18.99	80	65.88	17.91
Both	80	62.70	1-.77	80	64.95	17.77	160	63.83	17.31

As seen in Table 2 the mean for the posttest data for the direct instruction method (64.95), SD = 17.77, is higher that the mean for the exeperiencing mathematics method (62.70), SD = 16.77. The difference between the means indicated that there were practical differences among the groups. A comparison of the means of the pretest in Table 1 and the posttest scores in Table 2 between the treatment groups reveals that in both groups the mean increases. This result indicates that teaching mathematics by one of the instructional methods can be incorporated into regular classroom instruction, and students can improve their mathematics achievement. Using a two-way analysis of covariance with the pretest scores in Basic Mathematics Skills Test as a covariate the investigators determined the main effects of the treatment condition and mathematics anxiety levels. Interaction between treatment and mathematics anxiety levels was found.

Discussion

There was a significant difference between the means of the pretest

scores on achievement in mathematics of the experiencing mathematics instructional method and the direct instruction expository method. The results of the analysis of covariance with pretest scores (achievement in mathematics) as the covariate indicated that the two treatment groups of students who received mathematics instruction through the experiencing mathematics instructional approach, and the students participating in the direct instruction expository method, exhibited no significant difference between adjusted means of posttest scores in achievement in mathematics. There was also no significant difference between the high and low anxious students on adjusted means of posttest scores on achievement in mathematics.

Results showed no significant interaction in means of posttest scores between mode of instruction and anxiety level. Thus both treatments showed benefits in learning for students. Both modes of instruction appeared to help mathematics anxious students to change their attitudes toward mathematics in order to learn it. It seems that teaching students what they did not know is sufficient to improve their mathematics achievement. It may also have been that showing that the mathematics teacher is available not only to solve mathematical problems but also to motivate self-confidence in students' learning procedures encourages mathematics learning.

There is strong evidence that high-risk college students, regardless of level of performance in mathematics, experience moderate to high levels of mathematics anxiety. As a result their mathematics achievement is definitely affected. Effective treatments for mathematics anxiety at college must be implemented emphasizing self-confidence in doing mathematics. Actually, most of the teaching methods assume that the student is motivated and willing to take control of his/her learning. However, most students who participate in remedial courses of mathematics do not feel in control of or involved in their

learning (Crawford, 1980; Lasher, 1981; Mathison, 1977). From the weekly dialogue with the instructors it was revealed that the instructor's awareness and sensitivity to students' feelings about mathematics seemed to provide the students with the atmosphere conducive to changing negative attitudes towards mathematics.

Informal interviews with students in the experiencing mathematics method clearly revealed socialization and sharing of mathematics experiences helped students with severe anxiety levels in learning mathematics to feel relaxed and controlled in order to learn mathematics. However, it should be further noted that mathematics treatments appeared to affect positively the gain scores of both treatment groups in achievement in mathematics. Both remedial experimental groups showed gains in pretest-posttest mean scores of 100-item scores. The pretest mean score for the direct instruction expository method was 37.74 and the mean for the unadjusted posttest score was 64.95. The pretest mean score for the experiencing mathematics instructional method was 33.45 and for the unadjusted posttest score was 62.70. Thus both methods affected positively mathematics anxious students as evidenced by their gain in posttest achievement scores, resulting in a noteworthy practical, if not statistical, significance of both instructional treatments.

Conclusions and Recommendations

Either of the two treatments -- the experiencing mathematics instructional method or the direct expository instructional method -- can be successfully employed to improve mathematics achievement of remedial college students. Similarity in the results may have happened simply because teaching students what they did not know is sufficient to improve their mathematics achievement. Both treatments showed effectiveness in promoting mathematics achievement. Both experimental groups showed gains in mean scores; while the difference on

adjusted posttest means was not significant, the gains in mathematics achievement of both groups were notable. High and low mathematics anxious students were affected positively bo both instructional methods, as evidenced by their gains in posttest achievement scores.

References

Amidon, E., & Flanders, N. (1961). The effects of direct and indirect teacher influence on dependent prone students learning geometry. Journal of Educational Psychology, 52, 286-291.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. Psychological Review, 84, 203-215.

Betz, N. E. (1977, August). Math anxiety: What is it? Paper presented at the annual convention of American Psychological Association, San Francisco, CA.

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. Journal of Counseling Psychology, 25, 441-448.

Clute, P. S. (1984). Mathematics anxiety, instructional method, and achievement in a survey course in college mathematics. Journal for Research in Mathematics Education, 16(1), 50-58.

Crawford, G. (1980). Math without fear. New York: New Viewpoints.

Dellens, M. (1979, April). Math anxiety: What can a learning center do about it? Paper presented at the annual meeting of the Western College Reading Association, Waikiki, HI.

Donady, B., & Auslander, S. B. (Eds). (1980). Resource manual for counselors and math instructors. Washington, D.C.: Fund for Education and Human Services.

Eliot, J. (Ed.). (1971). Human development and cognitive processes. New York: Holt, Rinehart and Winston, Inc.

Gagné, R. (1970). Conditions of learning. New York: Holt, Rinehart and Winston, Inc.

Guthie, J. (1967). Expository instruction vs a discovery method. Journal of Educational Psychology, 58, 45-49.

Hacket, G. (1981, August). Mathematics self-efficacy and the consideration of math-related majors: A preliminary path model. Paper presented at the annual meeting of the American Psychological Association, Los Angeles, CA.

Heller, B. R., & Kogelman, S. (1982a). MART: Mathematics avoidance reduction techniques (III). Unpublished manuscript. New York: City University of New York, NYC, Center for Advanced Studies in Education.

Heller, B. R., & Kogelman, S. (1982b). Project MART: Encouraging the dissemination and use of instructional materials to counteract student's math avoidance. New York: City University of New York, NYC, Center for Advance Studies in Education.

Hendel, D. D. (1977). The math anxiety program: Its genesis and evaluation in continuing education for women. Minneapolis: University of Minnesota, Measurement Services Center.

Joyce, B., & Weil, M. (1980). Models of teaching. Englewood Cliffs, NJ: Prentice-Hall.

Kogelman, S., & Warren, J. (1979). Mind over math. New York: McGraw-Hill.

Lasher, A. M. (1981, April). Combatting math anxiety while building basic skills. Paper presented at the Conference in Remedial and Developmental Mathematics in College: Issues and innovations, New York, NY.

Mathison, M. A. (1977, August). Curricular interventions and programming innovations for the reduction of math anxiety. Paper presented at the American Psychological Association Symposium, San Francisco, CA.

Meece, J. L. (1981, April). Sex differences in achievement related effect. Paper presented at the annual meeting of the American Educational Research Association, Los Angeles, CA.

Nuthall, G. (1968). An experimental comparison of alternative strategies for teaching concepts. American Educational Research Journal, 5, 561-584.

Pace, J. P. (1981, April). Thematic teaching in remedial mathematics. Paper presented at the National Conference on Remedial and Developmental Mathematics in College: Issues and innovations, New York, NY.

Pines, S. F. (1981). A procedure for predicting underachievement in mathematics among female college students. Educational and Psychological Measurement, 41, 1137-1146.

Richardson, F. C. & Suinn, R. N. (1972). The Math Anxiety Rating Scale: Psichometric data. Journal of Couseling Psychology, 19, 551-554.

Schminke, C. W., & Arnold, W. (1971). Mathematics is a verb. Hinsdale, IL: Dryden Press.

Smith, J. B. (1979, March). Anxiety reduction in the developmental classroom. Paper presented at the Invitation to Innovation Conference, Wilmington, DE.

Stent. A. (1977). Can mathematics anxiety be conquered? Change, 9, 40-43.

Suinn, R. M., & Edwards, R. (1982). The measurement of mathematics anxiety: Mathematics Anxiety Rating Scale for Adolescents (MARS-A). Journal of Clinical Psychology, 38, 576-580.

Tobias, S. (1978). Overcoming math anxiety. New York: Norton.

Tobias, S., & Weissbrod, C. (1980). Anxiety and mathematics: An update. Harvard Educational Review, 50, 63-70.

Wagner, J. (1980). Math anxiety: Prevention and cure. Curriculum Review, 19(1), 58-59.

Woodruff, A. B., Shimabukuro, S., & Frey, S. H. (1965). Methods of programmed instruction related to student characteristics. Unpublished report, Northern Illinois University, De Kalb. ED 0033 35.

Wright, D. E., & Miller, L. D. (1981, November). Math anxiety: A research report. Paper presented at the annual meeting of the Mid-South Educational Research Association.